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ST/SSO/22
5 March 1974
ORIGINAL: ENGLISH

ENERGY

OUTLINE AND ANALYSIS OF ENERGY SECTOR

SUDANO-SAHELIAN REGION

Special Sahelian Office

74-05993

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Introduction

Energy resource availability, and the most efficient use of energy are questions of universal importance, arising largely because of the crucial role played by energy in the socio-economic development of a country and partly because of the effects of energy production and use on the environment. These questions have been further highlighted by recent changes in the production and supply of petroleum which commands the largest share of total world energy consumption.

The current drought situation in the Sudano-Sahelian countries (Chad, Mali, Mauritania, Niger, Senegal and Upper Volta) calls for a serious look into the energy situation of not only the individual countries but also of the region as a whole. Access to low-cost energy resources will play the important role of creating conditions for accelerated development of the area. Even more important, low-cost energy resources will be required in larger proportions in order for the countries to overcome the strains brought about by the drought.

The problems that face the Sudano-Sahelian countries with regard to energy are summarized below; they include:

(a) Lack of data on energy resource availability in each of the countries.

(b) Energy requirements for each country are met by supplies of imported oil and oil products, whose prices have increased substantially over the last three years. Payments for these imports and other essential imports, food, fertilisers and machinery and equipment have an adverse impact on the balance of payments and balance of trade positions of each of the countries.

(c) The supply of energy in the rural areas is inadequate.

(d) Four of the six countries are landlocked and are far from the sea, a fact which has resulted in high costs for imported oil products.

(e) Lack of energy institutions hinders proper planning and management of energy enterprises.

(f) Electricity generating plants are under-utilized.

(g) Power system, transmission and distribution networks are inadequate for meeting the growing demand for electricity.

(h) There is a lack of energy policy guidelines and comprehensive energy development plans.

The list is by no means complete but needless to say, practically all the above problems apply to developing countries in general. The situation in the Sudano-Sahelian countries has simply been aggravated by the current drought situation.

All six Sahelian countries have suffered from the drought, which has varied in intensity from country to country; the damage has thus not been uniform from country to country. The overall effect of this situation (drought and its impact) is likely to limit substantially the conditions necessary for the development of a viable infra-structure, and to limit further the possibilities and options for a regional approach to the problems. It is important to identify and appreciate these problems and consequences as they have a direct effect on each of the country's development capacity and hence their future energy requirements.

A number of actions will be required in order to deal with the situation, on both medium and long term basis. As a first step it is imperative to review and re-evaluate on-going projects in order to identify and emphasize areas of special priority.

On a medium-term basis a number of general and specific projects should be undertaken. These include such questions as the assessment of present and future energy requirements and an evaluation of the local or regional energy base to meet these requirements. Since most of the affected area is rural, special emphasis should be directed at an appraisal of energy requirements and supply to these areas. A more detailed list of the projects is given in the final pages of this report.

Questions of energy resource development are related to the development of other resources and activities and there is therefore a special need for co-ordinating these efforts with those in the realm of energy. Examples of the interrelationships are:

(a) Energy policies and plans should be formulated within the framework

of natural resources development policies and plans which should, in turn, form part of overall economic development policies and plans for each of the countries concerned in the context of regional development possibilities.

(b) Availability of low cost energy resources normally provides an impetus for the economic development of a country and this is expected to apply to the Sahelian countries.

(c) (i) On the one hand electricity generators, such as diesel plants, need water for cooling; on the other hand, small generators - diesel and others - may be required to pump water from wells.

(ii) Water resources can be used on a multipurpose basis for electricity generation, for irrigation, for flood control and for navigational purposes.

(d) Where mineral resources occur in commercially exploitable quantities their development requires increased energy supplies; mineral resource development is thus tied to an increase in energy demand.

(e) Adequate supply of energy in rural areas may stimulate the development of small-scale rural industries and may also result in increased agricultural production.

(f) Improved transportation may result in reduced transportation costs, especially those of imported oil and oil products.

(g) Energy consumption has been growing at a much faster rate than GDP.

Since several countries are affected, the prospects for inter-country and regional co-operation in energy matters should be evaluated. This is especially relevant since a number of the countries affected are not only energy deficient, but also landlocked, thus resulting in very high transportation costs for imported energy resources and products.

The report presents a brief survey of the energy situation in the six Sudano-Sahelian countries, covering the energy resource situation, past and future trends in energy consumption and problems of energy supply. Electricity production and consumption trends for each of the six countries are also covered, together with discussions for future prospects and requirements. The report concludes by making a number of suggestions for action in the form of projects - that will be required to deal with the situation of the Sudano-Sahelian countries.

Background to the Regional Economies

The six Sudano-Sahelian countries are situated in the Western part of Africa, and together cover some 5.3 million sq.km., more than 50 per cent of which is desert. Except for Mauritania and Senegal, the other four are landlocked, with no easy access to the coast, through which most of the exports and imports pass; the long distances from the seaports give rise to high transportation costs that are reflected in the final product prices, thus reducing the competitive position of the countries on the one hand, and increasing their foreign exchange burden, on the other.

Total population of the six countries has been estimated at about 24 million and has been growing at an average rate of 2.3 per cent during the last decade. (One quarter of the total population has been adversely affected by the drought.) The population is made up as follows: Chad 3.8 million; Mali 5.1 million; Mauritania 1.2 million; Niger 4.1 million; Senegal 4.0 million; and Upper Volta 5.5 million.

Apart from Senegal, whose industrial sector has been relatively well developed, and Mauritania, with a sizable mining sector, the economies of all six countries are dominated by agriculture and livestock production, both of which are largely undertaken at subsistence levels, so that only a relatively small proportion of their productions enters the monetized part of the economy. Drought has further aggravated the situation.

All six nations are poor, particularly Chad, Mali, Niger and Upper Volta, with per capita GDP of less than $100 - thus ranking them among the 25 world's least developed. The average growth rate of per capita national income for the six countries has been estimated at 2.7 per cent per annum for the 1960-1970 period.

For the 10-year period ending in 1971, average per capita national income annual growth rates of the countries ranged from a low of 2 per cent for Niger to a high of 3 per cent for both Mali and Upper Volta. Senegal's growth rate was 2.7 per cent - equivalent to that of the region as a whole - while Chad and Mauritania had 2.8 per cent and 2.9 per cent, respectively.

Per capita energy consumption for the six countries was only 48 kilograms of coal equivalent in 1971, compared with 348 for the developing countries and to 1951 for the world, in the same year. Per capita consumption ranged from a

low of 15 kilograms of coal equivalent for Upper Volta to 245 kilograms of coal equivalent for Mauritania. Senegal, with 197 kilograms of coal equivalent was close behind Mauritania, while Mali and Niger each had 31 and Chad had 27. The relatively high per capita consumption for Mauritania is largely due to the small population (1.2 million) as well as a sizable mining sector; the position of Senegal is, on the other hand, mainly attributable to the relatively well developed industrial sector.

The average rate of growth of per capita energy consumption for the region was, however, relatively high at 5.9 per cent. Mauritania, Chad and Niger, with an average rate of 21 per cent, 12.9 per cent and 11.8 per cent, respectively, experienced the fastest growth during the 1961-1971 period. A possible explanation for the observed phenomenon is the increase in energy intensive operations in the three countries.

Commercial Energy Consumption

The combined consumption of energy for the six Sahelian countries amounted to 1,132 mtce[1/] in 1971, which, although minimal compared with that of the developing countries (612.1 mtce) and of the world (4,416.1 mtce), was more than double the 506 mtce consumed by the same countries in 1961.

In the ten years between 1961 and 1971 the average annual rate of growth of energy consumption for the region was thus 8.4 per cent, much higher than the 6.9 per cent for the developing countries and the 5.4 per cent for the world.

There were considerable differences between individual countries with Upper Volta showing the lowest growth rate (5.1 per cent), followed, in ascending order by Senegal (5.3 per cent) and Mali (7.3 per cent). The other three countries had much higher growth rates: Niger (14.8 per cent), Chad (14.7 per cent) and Mauritania (25 per cent). (Table 2).

Based on the 1971 consumption figures, Senegal was the largest consumer (550 mtce) followed by Mauritania (171 mtce) - which also enjoyed the fastest consumption growth rate of 25 per cent per annum for the 1961/71 period. Niger and Chad were close behind with 105 and 104 mtce, respectively. Upper Volta had the lowest consumption, and, as has been noted above, the lowest growth rate in energy consumption.

1/ Metric tons of coal equivalent.

Energy Supplies

Oil has so far been the sole source of commercial primary energy for the six Sudano-Sahelian countries. This may be attributed to the price advantage so far enjoyed by oil and the relative convenience of use and transportation of oil and products. And, barring unforeseen major discoveries of natural gas or coal, oil will perhaps continue to be a major source of energy for the Sahelian countries.

Senegal produces some of its petroleum products requirements from a local refinery (capacity 600,000 m.t./year)[1]; the other five countries, however, import all their petroleum product requirements (Table 2). As can be seen from the table, even Senegal imports a large proportion of her petroleum products; so far only Senegal imports crude petroleum (Table 3).

The situation may, however, change appreciably in the years ahead, should the current mineral fuel exploration activities in the individual countries result in commercially exploitable discoveries.

The importation of crude petroleum and petroleum products constitutes a considerable financial and budgetary strain on the importing countries, which have to pay invariably for fuel imports in foreign currencies, thus further aggravating the already unfavourable balance of trade and payment situation. The situation for the Sudano-Sahelian countries has been made worse by the current drought situation as these countries need all the available financial (and other resources) to avert or at least contain the current emergency situation.

Table 4a shows fuel (largely petroleum and products) imports in USA dollars for each of the Sahelian countries between 1964 and 1970. The levels of imports noticeably differ from country to country, with Senegal importing the largest ($7.97 million in 1964 and $9.621 million in 1971). Upper Volta imports were the lowest ($1.399 million in 1961 and $3.825 million in 1971).

1/ It has been reported that a refinery of one million tons/year capacity will be built in Mauritania; three quarters of the refinery output will be exported to Europe (The Petroleum Economist, January 1974).

In general the average annual rate of growth in fuel import for all the countries has been very fast, except for Niger and Senegal with 2.7 per cent and 3.2 per cent, respectively. Mauritania had the fastest rate (26 per cent), followed by Upper Volta (18.4 per cent). Mali and Chad had respective rates of 9.8 per cent and 10.2 per cent.

In Table 4b, the relationship between mineral fuel imports and total imports for the Sahelian countries between 1964 and 1970 is shown. Although there are wide variations from country to country, mineral fuel imports constitute a large proportion of total imports in each case. In Chad for example, fuel imports are as high as 15 per cent on the average. It is also observed that the percentage of mineral fuel import in total imports has been rising over the six years considered and the trend must have increased much further over the last several months due partly to sharp increases in the price of petroleum products.

In Table 4c, large variations in unit values (prices) of petroleum products in Sudano-Sahelian Region are observed, with the unit values for Chad being the highest - at $124 per metric ton in 1970, compared with only $52 per metric ton for Mauritania in the same year. The relatively high unit values for Chad are mainly a reflection of the high transport cost of petroleum products in the country which is situated a long distance away from the coast. A similar situation applies, to a lesser degree, to Mali and Upper Volta. It is, however, difficult to explain the variations in respect of Mauritania and Senegal, both of which are similarly situated on the coast; the unit values were reasonably close between 1964 and 1966, but from 1967 those for Senegal jumped to nearly three times the 1966 value and have maintained the high value ever since. It should be noted that 1967 was also the year that the refinery in Senegal began production; it is, however, not clear whether there is any relationship between the sharp rise in the value of petroleum products, and the start of local production of these products in Senegal.

Recent steep rises in the prices of crude petroleum and products, have further aggravated the already serious situation for the energy-short developing countries, particularly those in the Sudano-Sahelian region. The full impact of oil and products price increases have not been ascertained; needless to say they will have far-reaching consequences on the economic

development of the developing countries - and in some cases, the very survival of some of them. The following is a brief discussion of the impact and potential impact of the recent price increases on the Sudano-Sahelian countries.

As has been mentioned above, practically all the Sudano-Sahelian countries depend almost entirely on imported energy; energy imports of these countries constituting more than 90 per cent of their consumption. The high dependence of these countries on imported energy makes them extremely vulnerable to the recent import price increase of oil and products. In 1970 fuel imports accounted for 7.3 per cent of the total imports of the six Sudano-Sahelian countries; with the recent sharp rise in oil prices, these countries will be required to pre-empt up to two to three times more of their imports for energy imports. This will naturally accentuate the already poor balance of foreign trade position of these countries. The situation will vary from country to country, but it is clear that these countries are being faced with many critical choices and efforts in regard to the future energy development and supply in the area, including:

(a) the development, as quickly as possible, of their indigenous energy resources, particularly petroleum, coal, hydroelectricity, and, to a smaller extent, geothermal, solar and wind energy resources;

(b) institution of ways of economizing and making efficient use of the limited energy resources they import;

(c) investigation into the ways and possibilities of obtaining preferential treatment from oil producing countries; and for landlocked countries, negotiations with neighbouring coastal countries for special rates that would in turn reduce the prices of oil and products;

(d) ensuring that the operations of foreign oil companies subserve to the developmental objectives of these countries, and not overcharge for their oil (and products) supplies;

(e) exploring ways and means of expanding their export earnings - in order to enable them to maintain the importation of essential developmental goods such as petroleum and products.

Future Requirements

We shall attempt a qualitative appraisal of energy requirements in the Sudano-Sahelian region ten years hence; it must, however, be emphasized at the outset that such an appraisal is an arbitrary exercise requiring certain basic assumptions including (1) energy price trends, (2) energy supply situation, (3) economic growth prospects for each of the countries and for the region as a whole, which will be directly and indirectly related to, (4) the continuation, or an early end to, the present drought situation of the area.

There are signs of a general increase in the global trade of energy, which will have a marked effect on the demand for energy, not only at the global level, but also at the regional and sub-regional levels, including the Sudano-Sahelian region. In addition, the price of petroleum (and products) has been rising very fast in recent months in relation to the price of other forms of energy, and the trend may very well continue in the future. The general impact of petroleum price increases has been discussed in the previous section. In this section we shall briefly speculate on measures that are most likely to be adopted by the affected countries. In all probability further increase in oil prices (coupled with the cut-back in oil production) may result in any one of the following (a) use of less energy-intensive applications, (b) substitution of oil by other forms of energy, (c) reduction in the consumption of oil (and products). These measures may have to be resorted to by the Sudano-Sahelian countries.

Alternative (a) is not likely, if only because the current applications are less energy-intensive anyway; (b) is even less likely since other forms of energy are simply not available and their importation and use are likely to cost much more than the current increases in petroleum prices will entail. Consequently, (c) is likely to be the preferred alternative. The level of reductions will depend on the nature of price increases coupled with the level of economic activity. A related factor in the supply of energy to the affected Sudano-Sahelian countries concerns the high cost of transport; transportation costs, and hence the price of oil, may be reduced somewhat through special agreements between the Sahelian countries and the countries supplying petroleum and products.

In general, energy supply situation is tied to the reserve situation of the time, not only from a global point of view, but also from the point of view of a region, such as Sudano-Sahel. For the immediate future, it is reasonable to believe that the supply of energy to the six countries in question will not be endangered, firstly because there are adequate energy reserves from the current suppliers; secondly, there are indications that more discoveries of oil reserves are likely in the region (in Nigeria, Gabon, Angola and Zaire). It is, however, in the interest of the Sudano-Sahelian countries to attempt, if possible, to obtain preferential terms for the supply of crude petroleum and petroleum products from the oil producing countries; this could also be tied to the question of establishing additional refineries in the region - which would depend on satisfactory agreements regarding crude supplies and on the economic attractiveness of small size refineries owned by foreign companies.

In general, it has been observed that a close relationship exists between energy consumption and economic development - both for developed as well as developing countries, including those in the Sudano-Sahelian region. If therefore an increase in the rate of economic growth and hence an increase in economic activity is envisaged for the region, then a corresponding increase in the consumption for energy should be expected; however, the nature and extent of the increase has yet to be established.

All the above factors can affect the expected rate of energy consumption, in one way or another, both in the region as a whole and in individual countries; it is extremely difficult to estimate the extent of their influence - either individually, or jointly. Under such circumstances, recourse can be made to the past historical trend in energy consumption, as an indicator of probable future consumption patterns. This is the course we have taken in the present discussions. Thus, we assume that the average rate of energy consumption for the Sudano-Sahelian region as a whole - 8.4 per cent per annum over the 1961/1971 period - will continue over the next ten to twelve years. Consequently, energy consumption for the six countries in 1985 will be 3.502 mtce. The average growth rate of 8.4 per cent is relatively high, compared with the rate for the developing market economies (6.7 per cent); if the latter rate of growth is assumed for the Sudano-Sahelian countries, then their level of consumption in 1985 will be 2.806 mtce.

It is difficult to estimate the future rate of growth for individual countries of Sahel, since the past decade has been marked by high, unfortunately high rates of growth that are unlikely to be maintained for the next ten to fifteen years. There are bound to be slowdowns in the rate of growth, which will vary from country to country although the extent of these variations and the factors bearing on them are difficult to ascertain.

Petroleum is expected to maintain its dominance but the position of gas and coal are uncertain. Hydropower potential has not been fully ascertained; the potential is, however, likely to be limited by the availability of water resources, especially for some of the Sudano-Sahelian countries, and it may thus constitute a very small percentage of total energy requirements in the area in the foreseeable future.

Electricity Consumption

The combined consumption of electrical energy for the six Sudano-Sahelian countries amounted to 601 million KWH for 1971, which, although small compared with the total consumption of the developing countries (332.83 x 10^6 million KWH), is nearly three times that (219 x 10^6 KWH) for the same countries in 1961, representing an average annual growth rate of 10.6 per cent in the ten year period (compared with 8.5 per cent for the developing countries and 7.4 per cent for the world).

Consumption growth rates in the ten year period have been more pronounced for most of the countries. Only Senegal had a lower growth rate than that for the region (7.2 per cent); Mali's consumption grew at the same rate as that for the whole region (10.6 per cent); Upper Volta's rate was 13.7 per cent, while Chad and Niger each experienced a high rate of 18.2 per cent. The fastest growth rate was again experience by Mauritania: 55 per cent; Mauritania's consumption grew from a mere one million KWH to over 78 million KWH in ten years (table 5), largely due to rapidly growing mining operations.

A possible explanation for the very high rates of growth observed for the Sudano-Sahelian countries may be that there was a definite shift from use of non-commercial sources of energy to commercial ones, such as transportation. Data on non-commercial energy use is not available. Another possible explanation may also be that there was an accelerated shift from less-energy-intensive economies to more-energy-intensive ones, which was certainly true of Mauritania - and to a small extent, Niger and Chad - with increased mining activities.

A closer look at table 2 reveals that Mauritania's energy consumption jumped from 44 million tons of coal equivalent in 1967 to 113 million tons of coal equivalent in 1968 representing an annual increase of over 283 per cent. A plausible explanation for this phenomenon is that the sudden increase in consumption corresponds to the time when certain mining operation, which are usually high energy users, began. The same phenomenon is noticeable in the Niger situation: a jump of 30 million tons of coal equivalent between 1970 and 1971, which corresponds to the time when uranium mining operations began in that country. Chad also had similar experience, thus its consumption rose from 63 to 83 tons of coal equivalent between 1968 and 1969 and again from 87 to 104 tons of coal between 1970 and 1971 - both corresponding to increase mining operations in the country.

Electricity Supply

Each of the countries meets its electricity requirements internally; and except for Mali, each of the countries is supplied from thermal generating stations (table 5). Even for Mali, except for the [illegible] per cent supplied from hydroelectric generating plants, the rest are supplied from thermal stations. Practically all the thermal generating stations are [illegible]-fired, thus accounting for the consumption of a sizable percentage of imported oil.

Oil will perhaps continue to be the major primary source of electricity. Although the hydroelectric generating capacity of the area has not been fully ascertained, it is unlikely to constitute a major source of electricity in the near future. In any case hydroelectric potential is not evenly distributed; only Mali and Niger and, to a small extent, Senegal are likely to possess economically exploitable potential. The situation with regard to coal is likely to change, depending on the outcome of current exploration, especially in Niger and Mali.

The total installed capacity for the Sahelian countries was only 265 MW in 1971. This, however, was a significant increase over the 88 MW of 1961, giving an average annual rate of growth for the period of 11 per cent. Again the rate of growth in installed capacity varied from country to country with Mauritania topping the list (43 per cent) and Senegal showing the lowest rate (8.7 per cent).

The level of development of generating capacity, and power systems generally, is still in an initial stage. Generating plants are still grossly under-utilized (table 5); in fact, for countries like Chad, the utilization factor has been decreasing over the 1961 1971 period - from 5,000 kWh kW to 1,[illegible] kWh kW. (8,760 kWh kW is equivalent to 100 per cent utilization, which is impossible to achieve in practice. However, a utilization factor of between 4,400 kWh kW - 50 per cent - to 5,800 kWh kW - 66 per cent - would be preferable).

It is difficult to diagnose the exact causes for such poor plant utilization factor for each of the countries. A possible cause may be the fact that practically all the generating plants for each of countries are still isolated from one another and do not form part of an interconnected system thus giving rise to the overbuilding of generating plants; where generating plants form part of an interconnected power system, the need for building a large stand-by capacity -

as security against plant breakdown - is reduced, so that plant utilization factor is improved.

Another possible cause may be the lack of qualified manpower for the operation and maintenance of the generating plants: this may also give rise to the over-building of the plants: that is, a disproportionately wide margin for plant failure is allowed for - much more than would normally be the case in situations where experienced and skilled manpower are available.

Yet another possible cause may be the high degree of uncertainty that face the planners of electricity systems such as those in the Sudano-Sahelian region. An optimal plan for additional plants presume adequate knowledge of future economic and industrial activities and of the requirements for electricity for the respective activities; by and large, such knowledge is unavailable, or inadequate at best. Consequently, in order to allow for all eventualities, the electricity system planner has to allow for possibilities of very fast load growth - allowances that naturally lead to the overbuilding of generating plants as, has certainly been the case for the Sudano-Sahelian region.

By far the most likely reason for the under-utilization of generating plant lies in the characteristics of the consumers' demands for electricity. Since the price of electricity tends to be high, its use is restricted to essential purposes with the result that demand load factors are depressed to low values.

The above diagnoses point to one major prescription namely institution building. Skilled manpower will be required in the whole spectrum of economic, industrial and technical activities, be they economic planners, statisticians, engineers, or managers. A definite step towards helping these countries in their institution building, is one of the most urgent requirements.

Trends in Electricity Development

The rate of growth in installed capacity in each of the Sahelian countries has noticeably slackened during the 1968/1971 period (table 7): and there is reason to believe that the rate has slackened further over the past two years, largely because the drought situation has deteriorated during the two years.

The drought situation is likely to be a factor in the medium term development of hydroelectric capacity as: continuation of the current drought situation and

the cumulative effect therefrom will certainly preclude consideration of large scale electricity development.

Availability of petroleum and products (fuel oil) at reasonable prices will also influence medium term development of electric capacity growth in the area, with any further price increases acting to hamper further growth. The probable impact of recent oil price increases has already been discussed above (the section on future energy requirements); this also applies to future electricity requirements, especially in view of the fact that the bulk of electricity in the region comes from oil-fired thermal stations. Needless to say, if the current increases in the price of petroleum should continue while no alternative sources of petroleum are forthcoming, then the price, and hence availability, of fuel oil will be a decisive factor in the development of the electricity sector in the area.

On a long term basis, such factors as trends in the industrial and general economic development of each of the Sudano-Sahelian countries will affect, directly or indirectly, developments in the electricity industry. From the point of view of economic development, such questions as whether economic activities will pick up pace after the slow down attendant disruption caused by the drought and would have to be weighed. Expected developments in the rural sectors of the economy will also affect electricity development there - with increased activities giving rise to increased demand for electricity.

Further electricity development may also be hampered by inadequate financial resources for capital investment. Investment in electricity development is highly capital-intensive, so that for these countries, that are short of financial resources to meet a multiplicity of requirements, a rational allocation of the scarce financial resources may not adequately meet the developmental requirements of the electricity industries. The implications of all this will need to be evaluated.

In examining future trends of electricity development in the Sudano-Sahelian countries due attention should also be given to developments possibilities in neighbouring countries. Primary energy resources availability and availability in the neighbouring countries will undoubtedly have a direct bearing on potential energy trade between these countries and the Sudano-Sahelian countries. Specifically,

in electricity, information on the status of the present and future power system development in neighbouring countries is required for an adequate assessment and evaluation of conditions conducive to interconnexions and the possibilities of future interconnexions with the Sudano-Sahelian countries.

The above discussion has concentrated on developments in generating capacity. No adequate information is available on corresponding developments in the transmission and distribution networks of each of the countries under discussion. There is a need for a preliminary survey by United Nations, or other, experts to evaluate the current status, and indicate the most probable schemes, for development in these areas.

Energy Resources Situation

So far there is little available information on the energy reserve situation in the area. A brief appraisal of the availability and potential availability of individual energy resources is given below: the appraisal is by no means comprehensive, largely because of the lack of adequate and up to date data. Collection of relevant data on the energy resource base and potential for each of the Sudano-Sahelian countries should therefore be given the urgent attention that it deserves.

Petroleum

There are prospects for the discovery of petroleum reserves in the area. The interior of Africa has large sedimentary basins, many of which are in the Sahelian countries. Needless to say, the amount and extent of exploration for petroleum in the area has been inadequate. There is a history of sporadic exploration over the past 20 years which has not, so far, resulted in any discoveries of oil or gas. The number of wells drilled, however, is utterly inadequate to evaluate the large areas involved. Most of the drilling activity to date has, in any case, been concentrated in the coastal areas of Senegal and Mauritania, leaving the vast interior areas almost unexplored. The past few years have, however, witnessed increased exploration activity in most countries, a summary of which is given below.

(a) Chad gave concessions to Continental/Shell; 10 months of seismic survey have been carried out; seismic survey continues into 1973.

(b) In May 1975, the Mali Government [illegible] the eastern part of the country (71,000 sq. km) to Mali Sun (51 per cent) and Global Energy Company (49 per cent) to carry out preliminary work prior to geologic and geophysical survey. Texaco has concessions on the Western part of the country, where they have carried out some reflection seismic survey.

(c) In Mauritania, although some companies reduced [illegible] there was an overall increase in the number of concessions [illegible] in the area (albeit with reduced holdings) and is carrying out seismic survey so is Agip, while Shell Maurex is carrying out marine seismic survey in their water concessions. Amo Co/Planet have also been active in the area of the Esso Mauritania Inc.; the pace of activities in general [illegible] especially in offshore exploration: CFP acquired some [illegible] for radioactive mineral survey.

(d) There were no changes in the holdings in Niger; the activities included geophysical and photogeologic (Global Co.), seismic survey (Texaco, Conoco/Shell), gravity magnetometer and aeromagnetic surveys (Global); no wells were drilled.

(e) In Senegal, although there were marked changes in the number of holdings, the amount of acreage under concession increased - generally distributed among COPETAO/Casamance Petroleum Co., Shell Seurex, Esso Senegal; geophysical activities increased; there were also activities in the offshore areas flanking Cap Vert Peninsula.

(f) No activity has so far been reported for Upper Volta.

Coal

There are indications of coal reserves in both Mali and Niger. In Mali further exploration is required in order to establish the extent and quality of the reserves. There is little information on the extent and quality of coal reserves near Agdez, Niger, discovered by a United Nations project. Further drilling has, however, been undertaken - through a bilateral arrangement - in order to ascertain the extent of these reserves, but the results of these are as yet unavailable.

Iron ore deposits are known to exist within [illegible] of the coal discovery in Niger. The proximity of two such primary industrial materials and the possibility that the coal might also be used for producing [illegible] fuel briquettes, suggest that further exploration and investigation should be intensified.

Oil shale

Although there are no reported occurrences of oil shale in the Sudano-Sahelian countries, the geological conditions of the area [illegible] that they may well occur. Some exploration effort may therefore be justified in order to obtain more detailed geological information on the availability of oil shale, particularly in view of the recent sharp increase in petroleum prices, a trend that may soon make the development of oil shale resources economically viable.

Uranium

Niger has substantial uranium reserves - currently estimated at over [illegible],000 mt of U_3O_8. Production by a combined French, Italian and German concern commenced in 1971. So far uranium mining is the most important mining activity in the country and since all the uranium produced is exported it is expected to account for over 50 per cent of exports in the 1970's.

Indications of uranium deposits in a number of areas in Chad have been listed by a geological survey: further exploration and survey are, however, still required in order to ascertain the nature and extent of the deposits. There are also deposit indications in the northern region of Upper Volta. Some uranium prospecting is currently in progress in Mali, but the outcome of this is difficult to forecast at the present time.

Geothermal

Geothermal manifestations have been observed in the Tibesti area of Chad: however, further survey is required to ascertain the potential of this as a source of electricity and/or water.

Hydroelectric potential

There are potential hydroelectric resources in Mali, Niger and Senegal. Mali currently has an installed capacity of [illegible] MW, which reduces to [illegible] MW during dry seasons. Further work is, however, required in order to establish the extent of hydroelectric potential and the distribution of this in the country.

Niger has a relatively large hydro-electric [illegible] of this and the feasibility of its utilization [illegible]. However, some preliminary survey of the [illegible] been undertaken, a summary of which is given in [illegible] of 2708 GWh is far in excess of the current and [illegible] of the country. Consideration should however be given to the [illegible] of electrical interconnexion with neighbouring [illegible] potential sites, at Dekrou, is situated on [illegible]

Hydroelectric potential in General in our [illegible] the Senegal river is limited to sites in the [illegible] countries, long distances (700 km) from the major load centres of [illegible] Taiba Phosphate mines.

Wind energy

Wind has been harnessed for many centuries but [illegible] in comparison with other forms of energy due to (a) its [illegible], (b) the inability of storing the energy cheaply and (c) the fact that it can not always be used when it is wanted. Furthermore, because of the low density of air, small capacity wind mills are bulky compared with their prime movers and the variability of wind speeds is not conducive to the desirable constancy of voltage and frequency. Unlike water power, wind power is, however, less restricted with regard to its location but its economic attractiveness is mainly a function of average annual wind speed.

The problem of matching load to the random availability of wind power can partially be solved - especially in less isolated areas - by parallel operation with a thermal (or a hydroelectric) plant, which can then pick up or reduce load so as to adjust to the difference between consumers' demand and the contribution from wind power. Parallel operation with thermal plants in this manner could result in fuel savings.

For isolated plants, the problem of load matching may be resolved by the introduction of some means of energy storage; alternatively, wind plants may be limited to supplying only loads that are not restricted in their time of incidence.

In either case there is need for a detailed study of the applicability of wind energy to suitable locations in the Sahelian countries; there is also need for further research and development work on the feasibility of developing adequate means of storage for plants in isolated areas.

Solar energy

The one energy resource possessed in abundance by the Sahelian countries is solar energy. Solar devices are practicable for small installations such as: water heaters (to the extent that hot water might be required in the Sahelian countries); solar stills for desalination of non-potable water; and solar cookers. Solar refrigerators have been built and will work, but are not available on a mass-production basis.

Since one of the prime factors in the spreading of deserts is deforestation, partly for the purposes of providing domestic fuel, it is believed that a serious effort should be made to demonstrate the practicability of solar devices for domestic cooking purposes, especially at the village level. The problems are not so much technical as social and economic (insofar as the devices exist and have been proved to work, but may yet have to be accepted (and maintained) by the local population as a working substitute for traditional fuels such as wood. Even in instances where the use of solar energy has been accepted, there are still problems of finding solar devices that could be utilized cheaply.

While it does not appear that solar powered prime movers (pumps and engines) or electrical generators are viable for the Sahelian region at the present time, every effort should be made to encourage serious research institutions to field-test experimental machines within the framework of a Sahelian solar energy programme.

The possibility of the practical realization of solar energy potential in the arid countries of West Africa has been of great interest to the United Nations. Accordingly the Economic Commission for Africa recommended (March 1964), and the Economic and Social Council endorsed (August 1964), the Establishment of a Solar Energy Experimental Centre in Niamey, Niger. The specific aims of the proposed centre were envisaged to be as follows:

(a) to measure solar radiation and other climatic factors affecting solar energy utilization in the Sahelian area; (b) to educate technicians in the use and maintenance of solar devices, primarily for rural purposes; (c) to test existing devices under field conditions; (d) to explore possibilities for the utilization of local materials for manufacture of solar energy devices; (e) to explore possibilities for the practical utilization of solar and terrestrial energy for the various applications envisaged at different points in the Sahelian countries; (f) to evaluate the present state of practical research and development work in Niger and other Sahelian states; and (g) to broaden the programme and organization of the Niamey Centre in the light of its regional role.

The Centre was established in late 1966, and between January 1967 and July 1968, United Nations experts worked at the Centre, engaged in the analysis of radiation incidence, supervision of the installation, maintenance of radiation measuring equipment, and meteorological measurements. The experts also worked on the possibilities of installing experimental radio stations operated by solar power and of water pumping experiments using a small solar operated motor.

The United Nations involvement in the activities of the Centre came to an end in 1968, and detailed information is limited on what progress has been made during the intervening period.

In view of difficulties which are at present being experienced in the field of energy supply, it might be appropriate for the United Nations once more to take an interest in the possible applications of solar energy to energy needs of developing countries particularly the Sudano Sahelian countries. As a first step, it would be necessary to obtain information on the latest progress in this field. Subsequently, consideration might be given to the advisability of setting up a pilot project sponsored by the United Nations aimed at the site-testing of solar energy apparatus at a suitable village location. Such a scheme could have for its object the economic and technical evaluation of the equipment with particular reference to such aspects as ease of operation and maintenance and an assessment of overall cost/benefit ratio.

Suggestion and Action Required in the Field of Energy

For the present purposes we shall be concerned with medium-term and long-term action required in the energy sector. The measures taken will depend mainly on whether the drought situation is temporary or whether it extends over a long period of time. If temporary, the action taken may be such as to offset the disruption created by the drought situation and perhaps prepare the countries to be able to cope with any future occurrence of drought. If permanent, then the action to be taken, both medium and long-term, have to be geared to such end.

In working out the strategies and programmes for energy development, care must be taken to ensure that these are consistent with overall economic development strategies and priorities of the countries in question. The development strategies and priorities must be arrived at through consultation between appropriate substantive organs, both within and outside the United Nations System, on the one hand, and the respective governments on the other hand. By its very nature, the current problem involves all aspects of human existence and any approach to the solution must of necessity be interdisciplinary, with all the sections, divisions, departments, agencies and intergovernmental groups and organizations working in a joint and coordinated effort.

The action taken should also be that likely to stimulate the economic activities and development of the countries concerned, both individually and regionally. The development of mineral resource potential, of a strong manufacturing and other secondary industrial base and of improved agriculture and industries that are related to agriculture fall into this category. The development of all of these will, of necessity, require substantial increases in the use of energy. In fact, the availability of adequate energy resources is crucial for their development. Action taken in the planning of these activities should therefore be closely tied-to and coordinated with the plans to develop the requisite energy resource base, and of adequate energy supply and distribution capabilities and facilities.

In the following pages action required for the development of individual energy resources, or where appropriate, specific areas of activities in energy, are briefly outlined, from either general, long-term or medium-term points of view.

Petroleum

The Governments of the Sahelian countries would benefit from the services of a small consulting group. The group could advise on all aspects of petroleum exploration and development, including legal, administrative, technical, economic and policy matters. Such a group would be at the service of any of the Governments for the following specific purposes:

1) Revision and/or drafting of petroleum legislation and agreements.
2) Negotiation of exploration and development agreements between Governments and private interests.
3) Supervision of the activities of concessionaires and contractors to ensure compliance with the terms of their agreements.
4) Evaluation of any discoveries of oil or gas. This would be of particular importance in the case of so-called "non commercial" discoveries. Owing to the great distances from the interior of the Sahelian countries to the sea, and the small size of the local petroleum market, a discovery would have to be very large for it to be considered "economic" by a foreign concessionnaire. On the other hand, such a discovery might very well be of interest to the Government from the standpoint of supplying local demand, since the Government would not have incurred any exploration cost for the discovery.
5) Evaluation of the feasibility of establishing small-size refineries to meet the needs of the region or sub-region.

The discovery and production of petroleum would give a much-needed impetus to economic and industrial activities. Earnings from petroleum exports would also aid the foreign exchange position of the countries in question.

Coal

A detailed appraisal of the extent and quality of coal reserves together with the feasibility of their commercial exploitation is suggested.

In Niger the proximity of iron ore deposits to potential coal sites merits further detailed investigation.

Hydroelectric Potential

1) Detailed survey of hydroelectric potential and distribution should be carried out in Mali.
2) Further appraisal of the hydroelectric potential of Niger, especially with regard to a) possibilities for the interconnexion of load centers in Dahomey to the hydroelectric site at Mekrou; b) interconnexion of Niamey, Niger to the hydroelectric generating stations at Kaindji, Nigeria - with Niger assuming some specified part of the development and running costs.
3) Further survey of the hydroelectric potential of the Senegal river should be undertaken together with the feasibility of transmitting electricity from these sites to load centers in Senegal.
4) Appraisal of the feasibility of interconnecting load centers in Chad to hydroelectric and potential hydroelectric generating stations in Cameroon should be carried out.

In each of the above cases the development of hydroelectric sites should be studied and viewed on a multi-purpose basis, with attention given, where appropriate, to considerations of irrigation, navigation and flood control.

Wind Energy

As has been emphasized above, there is need for (a) detailed study of the applicability of wind energy in suitable locations in the Sahelian countries; (b) further research and development on the feasibility of developing adequate means of energy storage for plants in isolated areas.

Solar Energy

This should largely be educational, involving efforts to popularise the use of solar energy as an alternative means of domestic cooking.

1) Active demonstration at the Village level, of selected solar devices, e.g. solar cookers, heaters, refrigerators and distillators.
2) Solar devices should be distributed to interested members of the population at relatively low prices, and their continued use should be encouraged.

3) Local craftmen should be trained in the construction, setting up and operation of simple solar devices.

4) Ample supplies of the reflective filar and other specialized materials used in making solar cookers should be provided.

While it does not appear that solar powered prime movers (pumps and engines) or electrical generators are viable for the Sahelian region at the present time, every effort should be made to encourage serious research institutions to field-test experimental machines within the framework of a Sudano-Sahelian solar energy programme.

Rural Energy Supplies

This should be part of a joint and coordinated effort by all the parties concerned, with a view to formulating a rational, comprehensive rural development programme. The availability of energy and energy supplies in rural areas, will play a crucial role in the programme. In this connexion, the following effort will need to be undertaken:

1) survey of energy requirements in rural areas;

2) appraisal of energy requirements, supply situation and ready availability of energy resources in the rural areas for each of the Sudano-Sahelian countries;

3) evaluation of the sources, terms and availability of financial resources required for energy supply and use in the rural areas;

4) appraisal of institution-building requirements for the supply of energy in the rural areas of the countries in question;

5) evaluation of planning, design and operational characteristics to suit the special rural areas;

6) formulation of policy guidelines for the development of energy supplies to the rural area.

Overall Energy Situation

In addition to the special emphasis on rural energy supply discussed above, there is an imperative need to look at the total energy situation for each of the countries. In general, it may, in fact, be advantageous and advisable to tackle

the total energy situation first and view rural energy supplies as an integral part of the total energy situation. For the present discussion, however, rural energy supplies are treated separately because a large bulk of the population lives in the rural areas, and rural development programmes, including rural energy supplies require special emphasis. Many factors are to be covered under this, including:

1) appraisal of the future energy requirements for each of the countries;
2) evaluation of the energy resource base, and energy supply options to meet the expected energy demand;
3) Policy and planning procedures and processes to ensure that the energy requirements and energy development objectives are not subject to the specified resource constraints, availability and supply constraints and subject to the availability of requisite financial resources;
4) development of adequate training procedures to meet the demands for proper institution-building in the energy industry.

The approach should emphasize regional programmes. The geographical location of the Sudano-Sahelian countries, many of which are landlocked, brings in focus the need for regional cooperation, not only amongst the six countries themselves, but also with the surrounding and neighbouring countries. Regional approaches will not only cover such matters as inter-country and intra-country fuel transportation arrangements and refinery agreements, but also electricity network interconnexions.

Other

Projects suggested under this heading are more general in character, and are conducive to a multi-disciplinary approach; they include:

1) Development of ways and means for saving the scarce energy resources - through selective utilization of energy resources;
2) Control of erosion, through the development and use of other forms of energy other than wood in the rural areas;
3) Water supplies for rural, irrigation and industrial use (through water-pump and desalination processes, using the available and unconventional energy resources.)

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Table 1

SUDANO-SAHELIAN COUNTRIES: NATIONAL INCOME AND ENERGY CONSUMPTION

Countries	Population 1971 (millions)	National income per capita in 1971 (US $)	Energy consumption per capita in 1971 (kg of c.e.)*	[illegible]	[illegible]	[illegible]
Chad	3.8	78	27	.2	[illegible]	[illegible]
Mali	5.1	90	25	[illegible]	[illegible]	[illegible]
Mauritania	1.2	144	143	[illegible]	[illegible]	[illegible]
Niger	4.1	93	25	[illegible]	[illegible]	[illegible]
Senegal	4.0	240	137	[illegible]	[illegible]	[illegible]
Upper Volta	5.5	56	[illegible]	[illegible]	[illegible]	[illegible]
T o t a l	23.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Sources: U. N. Statistical Office Print-outs and World [illegible] Statistical Papers, Series J, No. 16

* Kilograms of Coal Equivalent

** Per Capita

*** National Income

Table 2

Trade and Consumption of Energy in Countries of Sahelian Region

(in 10^3 tons of coal equivalent and kilograms per capita)

		Imports	Exports	Bunkers	Consumption	Consumption per Capita
CHAD	1961	27	2	-	26	8
	1962	42	2	3	37	12
	1963	49	-	4	45	14
	1964	52	-	6	46	14
	1965	58	-	9	49	15
	1966	43	-	3	40	12
	1967	61	-	4	57	16
	1968	68	-	4	63	18
	1969	87	-	4	83	23
	1970	93	-	6	87	23
	1971	111	-	7	104	27
Growth Rate 1961-71%					14.9	12.9
MALI	1961	61	-	-	62	15
	1962	71	-	-	71	16
	1963	81	-	-	81	18
	1964	90	-	-	90	20
	1965	99	-	-	99	22
	1966	98	-	-	98	21
	1967	114	-	-	114	24
	1968	102	-	-	102	21
	1969	80	4	-	75	15
	1970	99	-	-	99	20
	1971	128	-	-	128	25
Growth Rate 1961-71%					7.5	5.2
MAURITANIA	1961	23	-	3	19	22
	1962	30	-	4	26	29
	1963	34	-	6	28	28
	1964	45	-	4	40	39
	1965	48	-	6	42	40
	1966	54	-	11	43	41
	1967	57	-	14	44	40
	1968	125	-	12	113	101
	1969	126	-	3	123	108
	1970	162	-	6	156	133
	1971	182	-	11	171	143
Growth Rate 1961-71%					25	21
NIGER	1961	27	-	-	27	9
	1962	33	-	-	33	10
	1963	45	-	-	45	14
	1964	45	-	-	45	13
	1965	43	-	-	43	12
	1966	60	-	-	60	17
	1967	60	2	-	58	16
	1968	68	-	-	68	18
	1969	58	2	-	57	15
	1970	75	-	-	75	19
	1971	105	-	-	105	25
Growth Rate 1961-71%					14.5	10.8

Table 2 (Continued)

		Imports	Exports	Bunkers	Consumption	Consumption Per Capita
SENEGAL	1961	1790	-	1463	327	103
	1962	1887	-	1509	378	116
	1963	1876	-	1487	488	147
	1964	1846	-	1397	458	135
	1965	1793	-	1350	518	149
	1966	1752	18	1269	527	14[illegible]
	1967	2476	-	2049	527	146
	1968	2719	89	2256	455	123
	1969	2394	91	1899	433	129
	1970	2409	117	1838	523	133
	1971	2206	118	1575	550	137
Growth Rate 1961-71%					5.3	2.9
UPPER VOLTA	1961	45	-	-	45	10
	1962	42	-	-	42	9
	1963	45	-	-	45	10
	1964	54	-	-	54	11
	1965	51	-	-	51	10
	1966	54	-	-	54	11
	1967	51	-	-	51	10
	1968	51	-	-	51	10
	1969	60	-	-	60	11
	1970	69	-	-	69	13
	1971	74	-	-	74	13
Growth Rate 1961-71%					5.1	2.7

Note: (a) The above countries had no production of primary energy during 1961-1971, with the exception of Senegal which produced crude petroleum (3,000 and 1,000 metric tons of coal equivalent in 1961 and 1962 respectively).

(b) All trade and consumption consist of liquid fuels.

Source: World Energy Supplies, No. 15, 16.

Table 3

SENEGAL: Production, Trade and Apparent Supply of Crude Petroleum, and Refinery Capacity
(thousand metric tons)

Year	Production	Imports	Apparent Supply	Refinery Capacity
1963	-	10	10	350
1964	-	290	290	350
1965	-	448	448	500
1966	-	455	455	500
1967	-	511	511	500
1968	-	570	570	500
1969	-	600	600	600
1970	-	563	563	600
1971	-	563	563	600

Source: World Energy Supplies, J-15,16.

Table 5b

SENEGAL: Production of Petroleum Product.
(thousand metric tons)

Year	Motor Spirit	Kerosene and Jet Fuel	Distillate Fuel Oils	Residual fuel Oils
1967	100	75	125	210
1968	92	74	127	250
1969	95	81	124	262
1970	101	88	143	303
1971	85	90	127	266
1972	119	98	160	346

Source: Monthly Bulletin of Statistics, October 1973.

Table 4a

Fuel Imports of Countries in Sahelian Region
(In thousand U.S. dollars)

Country	Commodity	1970	1969	1968	1967	1966	1965	1964
Chad	Mineral Fuels	9,621	7,546	5,556	5,513	4,440	6,334	4,819
	Coal	-	-	-	-	-	-	-
	Petroleum	9,581	7,490	5,479	5,452	4,337	6,333	4,746
	Gas	-	-	-	-	-	-	-
Mali	Mineral Fuels	4,007	3,435	2,662	3,943	2,302	2,563	2,291
	Coal	-	-	-	-	-	-	-
	Petroleum	3,975	3,405	2,636	3,911	2,282	2,466	2,267
	Gas	-	-	-	-	-	-	-
Mauritania	Mineral Fuels	4,322	N.A.	2,616	1,348	1,316	1,164	1,074
	Coal	459	N.A.	-	-	-	-	-
	Petroleum	3,732	N.A.	2,471	1,231	1,221	1,034	1,019
	Gas	-	N.A.	137	115	-	-	-
Niger	Mineral Fuels	2,318	2,067	2,320	2,732	N.A.	2,382	2,707
	Coal	-	-	-	-	N.A.	-	-
	Petroleum	2,239	2,012	2,256	2,673	N.A.	2,332	2,663
	Gas	-	-	-	-	N.A.	-	-
Senegal	Mineral Fuels	9,621	14,842	5,556	1,150	9,937	10,263	7,973
	Coal	-	-	-	-	-	-	-
	Petroleum	9,549	14,776	5,492	1,099	9,679	10,038	7,736
	Gas	-	-	-	-	241	174	143
Upper Volta	Mineral Fuels	3,825	3,300	2,762	2,357	2,209	1,941	1,399
	Coal	-	-	-	-	-	-	-
	Petroleum	3,774	3,257	2,716	2,331	2,142	1,847	1,374
	Gas	-	-	-	-	-	-	-

Source: Commodity Trade Statistics, Statistical Papers, Series D.

Table 4b

Fuel Imports as Percentage of Total Imports of Countries in Sahelian Region

(total & fuel imports in thousand U.S. dollars)

Country		1961	1962	1963	1964	1965	1966	1967a
Chad	Total Imports	55,723	46,280	[illegible]	[illegible]	28,729	[illegible]	34,5[illegible]
	Fuel Imports	[illegible],821	[illegible],546	5,5[illegible]	[illegible],[illegible]47	[illegible],[illegible]46	[illegible],394	[illegible],819
	%	25.5	26.5	20.5	24.7	[illegible]	[illegible]	[illegible]
Mali	Total Imports	[illegible],7[illegible]	38,912	34,2[illegible]	51,715	35,953	42,[illegible]	36,[illegible]47
	Fuel Imports	[illegible],[illegible]07	[illegible],435	[illegible],662	3,943	2,302	[illegible],563	2,291
	%	[illegible].9	[illegible].3	7.8	7.6	6.4	6.0	6.3
Mauritania	Total Imports	55,[illegible]55		35,2[illegible]8	36,[illegible]35	23,[illegible]83	24,[illegible]72	15,720
	Fuel Imports	4,322	n.a.	2,626	[illegible],[illegible]48	[illegible],[illegible]26	2,104	1,[illegible]74
	%	7.7		7.4	3.7	5.7	4.4	6.3
Niger	Total Imports	58,[illegible]68	43,700	[illegible]1,471	[illegible]5,[illegible]72		[illegible]7,65[illegible]	[illegible]3,5[illegible]8
	Fuel Imports	[illegible],[illegible]18	2,067	[illegible],320	[illegible],[illegible]32	n.a.	2,[illegible]32	[illegible],[illegible]27
	%	4.0	4.2	5.6	[illegible].9		[illegible].3	[illegible].1
Senegal	Total Imports	192,429	198,648	[illegible]90,[illegible]81	157,357	[illegible]60,913	[illegible]84,[illegible]24	171,[illegible]71
	Fuel Imports	9,621	14,842	5,556	1,150	[illegible],937	[illegible],[illegible]63	[illegible],[illegible]73
	%	5.0	7.5	3.1	0.7	[illegible].2	[illegible].2	4.6
Upper Volta	Total Imports	[illegible]4,799	38,912	34,2[illegible]8	[illegible]1,[illegible]29	35,[illegible]53	42,[illegible]22	[illegible]6,[illegible]47
	Fuel Imports	[illegible],[illegible]07	[illegible],435	2,[illegible]62	[illegible],[illegible]43	[illegible],[illegible]02	2,563	[illegible],[illegible]91
	%	[illegible].9	[illegible].3	[illegible].3	[illegible].6	[illegible].4	[illegible].0	[illegible].3

Source: Commodity Trade Statistics, Statistical Papers, Series D.

Table 4c

Imports of Petroleum Products (SITC 332) into Countries in Sahelian Region (c.i.f)*

Country		1970	1969	1968	1967	1966	1965	1964
Chad	Q	69,245	66,069	46,634	41,337	29,534	39,609	39,992
	V	8,541	7,493	5,479	5,451	4,387	6,233	4,706
	U	124	113	117	130	149	160	119
Mali	Q	71,300	58,494	74,000	62,096	74,730	71,611	70,257
	V	3,975	3,405	2,635	3,911	2,231	2,.65	2,.47
	U	56	58	36	48	31	3.	32
Mauritania	Q	116,551		76,997	40,860	45,032	37,585	31,506
	V	3,782	N.A.	2,471	1,231	1,221	1,034	1,019
	U	32		32	30	27	28	32
Niger	Q	51,623	41,027	48,359	42,928		31,127	77,769
	V	2,239	2,012	2,256	2,673	N.A.	2,332	2,663
	U	43	49	47	62		75	34
Senegal	Q	19,701	24,515	15,240	11,582	199,570	154,617	123,934
	V	1,460	1,901	1,411	1,099	7,054	5,121	4,189
	U	74	78	89	95	35	33	34
Upper Volta	Q	50,843	43,127	35,792	35,738	34,964	36,448	35,631
	V	3,774	3,257	2,716	2,331	2,182	1,547	1,370
	U	74	76	76	65	62	42	38

Source: Commodity Trade Statistics, Statistical Papers, Series D.

Note: Q - quantity in metric tons
V - value in thousand U.S. dollars
U - unit value in U.S. dollars per metric ton
*Standard International Trade Classification

Table 5

Electricity Production and Installed Capacity of Countries in Sahelian Region

		Capacity (MW)	Production (10^9 KWh)	Utilization (KWh/KW)
CHAD[a]	1961	3	9	[illegible]
	1962	3	11	[illegible]
	1963	9	13	[illegible]
	1964	10	16	[illegible]
	1965	10	18	[illegible]
	1966	15	22	[illegible]
	1967	15	26	[illegible]
	1968	25	31	[illegible]
	1969	32	37	1187
	1970	30	42	[illegible]
	1971	30	47	[illegible]
Growth Rates:	1961-71	26	18.2	
p.a.	1968-71	6.3	12.7	
MAURITANIA[b]	1961	1	1	[illegible]
	1962	1	1	[illegible]
	1963	2	3	[illegible]
	1964	3	5	[illegible]
	1965	21	30	[illegible]
	1966	21	36	[illegible]
	1967	24	38	[illegible]
	1968	25	44	[illegible]
	1969	24	56	[illegible]
	1970	36	72	[illegible]
	1971	36	78	[illegible]
Growth Rates:	1961-71	43	53	
p.a.	1968-71	12.9	21	
NIGER[a]	1961	3	9	3000
	1962	3	14	[illegible]
	1963	7	14	[illegible]
	1964	8	15	[illegible]
	1965	6	16	[illegible]
	1966	11	20	[illegible]
	1967	11	24	[illegible]
	1968	13	[illegible]	[illegible]
	1969	14	30	[illegible]
	1970	15	39	[illegible]
	1971	15	48	3200
Growth Rates:	1961-71	17.5	18.[illegible]	
p.a.	1968-71	4.9	19.[illegible]	

Table 5 (Continued)

		Capacity (MW)	Production (10^6 KWh)	Utilization (kwh KW)
SENEGAL[a]	1961	68	174	2559
	1962	70	175	2500
	1963	70	160	2671
	1964	69	220	1[illegible]
	1965	71	230	[illegible]
	1966	87	259	[illegible]
	1967	95	474	[illegible]
	1968	96	287	[illegible]
	1969	108	320	[illegible]
	1970	108	330	[illegible]
	1971	108	350	[illegible]
Growth Rates:	1961-71	4.7	7.2	
% p.a.	1968-71	4.0	6.3	
UPPER VOLTA[a]	1961	4	10	[illegible]
	1962	5	14	[illegible]
	1963	6	16	[illegible]
	1964	8	19	[illegible]
	1965	10	21	[illegible]
	1966	11	22	[illegible]
	1967	11	21	[illegible]
	1968	11	23	[illegible]
	1969	10	25	[illegible]
	1970	14	27	[illegible]
	1971	14	33	[illegible]
Growth Rates:	1961-71	13.3	12.7	
% p.a.	1968-71	8.4	13.5	

		Capacity (MW)			Production (10^6 KWh)			Utilization (kwh K		
		Thermal	Hydro	Total	Thermal	Hydro	Total	Thermal	Hydro	Tot
MALI[b]	1961	9	1	10	15	1	16	[illegible]	1000	[illegible]
	1962	9	1	10	18	1	19	[illegible]	1000	[illegible]
	1963	9	1	10	20	1	21	[illegible]	1000	[illegible]
	1964	10	1	11	25	1	[illegible]	[illegible]	1000	[illegible]
	1965	11	1	[illegible]	27	1	[illegible]	[illegible]	1000	[illegible]
	1966	14	1	[illegible]	31	1	[illegible]	[illegible]	1000	[illegible]
	1967	14	1	[illegible]	[illegible]	1	[illegible]	[illegible]	1000	[illegible]
	1968	14	1	[illegible]	[illegible]	1	[illegible]	[illegible]	1000	[illegible]
	1969	[illegible]	1	[illegible]	[illegible]	1	[illegible]	[illegible]	1000	[illegible]
	1970	19	1	[illegible]	[illegible]	1	[illegible]	[illegible]	1000	[illegible]
	1971	19	1	[illegible]	[illegible]	1	[illegible]	[illegible]	1000	[illegible]
Growth Rates:	1961-71			7.2			[illegible]			
% p.a.	1968-71			10.1			[illegible]			

Source: World Energy Supplies, Series J, No. 15 and 16.

a All public and thermal.

b All public.

Table 6

Niger: Hydroelectric Potential

	Capacity Installed (MW)	Capacity Firm (MW)	Energy Average per year (GWh)	Transmission Distance to Niamey (km)
Mekrou	15	7.5		1
" 1st Stage	24	0	17	1
" Final Stage	34	0	5	
Kandadji			13	